IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

David L. DOOLEY   Art Unit: 2616

Application No: 09/847,076   Examiner:
                                          Ian N. Moore
Filed: May 1, 2001

For: NETWORK SWITCH PORT WITH WEIGHTED
     RANDOM EARLY DISCARD

TRANSMITTAL OF BRIEF ON BEHALF OF APPELLANT

COMMISSIONER FOR PATENTS
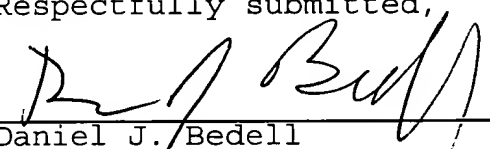P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

   Notice of Appeal was filed in this case on July 11, 2006.

   Submitted herewith in triplicate is Appellant's Brief.

   A check in the amount of $500 for the fee under 37 CFR 41.20
(b)(2) is enclosed.

                              Respectfully submitted,

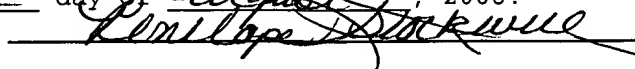   Daniel J. Bedell
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PATENT

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In re Application of

David L. DOOLEY   Conf. No: 6972

Application No: 09/847,076   Art Unit: 2616

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Sir:

Real Party In Interest

Integrated Device Technology, Inc.

Related Appeals and Interferences

None

Status of Claims

Claims 1-18 are pending.

Claims 1, 2, 7, 10-12, and 17 are rejected.

Claims 3-6, 8, 9, 13-16 and 18 are objected to as dependant on rejected claims.

Claims 19 and 20 have been withdrawn.

Status of Amendments

Pending amendments were filed on July 18, 2006 and on August 1, 2006 subsequent to final rejection to correct informalities in claims 1, 8, 11 and 18.

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Summary of Claimed Subject Matter

Claim 1 and 11

The invention relates to an input port for a network switch for routing packets between buses connected to the network switch. Each input port breaks an incoming packet arriving on a bus into a sequence of cells and then normally stores each cell of the sequence in a separate block of memory until it can forward the cell to an appropriate output port. The receiving output port assembles the cells back into a packet and forwards the packet outward via an outgoing bus. When one or more of the switch's output ports cannot forward packets quickly enough, the buffer memory in one or more of its input ports could fill up with cells to be routed to those output ports. As recited in claims 1 and 11, as it breaks an incoming packet into a cell sequence, the input port determines whether to store at least one cell of the sequence in the memory or to discard the cell, based on an estimated average number of cells stored in the memory during a period immediately preceding generation of the estimate. Thus the input port breaks variable sized incoming packets into cells and then determines on a cell-by-cell basis (rather than on a packet-by-packet basis) whether to store each cell in memory or to discard it.

Claims 2 and 12

Claims 2 and 12 depend on claims 1 and 11, respectively, and further recite that a cell to be discarded or stored is assigned a discard weight as a function of the estimated average number of cells stored in the memory. The discard weight is compared to a randomly generated number to produce result data indicating whether the discard weight of that particular cell exceeds the value of the random number. The determination as to whether to discard the cell or to store the cell in the memory is then made as a function of the result data. Thus the determination as to whether to store a cell in memory or discard not only depends on an average number of cells in the memory during a period immediately preceding the determination, but also on a random number.

Claim 10

Claim 10 depends on claim 1 and further recites that the average number of cells stored in the memory is estimated whenever there is a change in a number of cells currently stored in the memory.

Claims 7 and 17

Claims 7 and 17 depend on claims 1 and 11, respectively, and further recite an iterative approach to estimating the average number of cells stored in the memory. A last computed average number of cells stored in the memory is multiplied by a value of a parameter X between 0 and 1 to produce a first value, a number of cells currently stored in the memory is multiplied by a quantity (1-X) to produce a second value, and a next estimate of the average number of cells stored in the memory is produced as a sum of the first and second values.

Grounds for Rejection to Be Reviewed On Appeal

Grounds for rejection to be reviewed on appeal are whether claims 1, 2, 7, 10, 11, 12 and 17 should be rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of U. S. Patents 6,721,316 (Epps) and 6,529,478 (Schwartz).

Argument

Claims 1 and 11

Claims 1 and 11 recite generating a cell sequence corresponding to an incoming packet and making a determination with respect to at least one cell of the sequence as to whether to store the cell in memory or discard it. Thus only <u>cells</u> derived from incoming packets and <u>not the packets</u> themselves are stored in memory, and the determination as to whether to discard or store is made on a <u>cell-by-cell</u> basis before storing the cell in memory.

Schwartz (col. 9, lines 7-10) teaches a network switch input port 20(n) (FIGs. 2, 3) that receives and stores an entire incoming packet in an internal packet memory 31 without first breaking the packet into cells. After storing the incoming packet in memory, the input port sends a "metadata packet" describing the incoming packet

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and its memory address to a metadata processor 23 (col. 6, lines 36-52). Metadata processor 23 thereafter decides whether the packet stored in memory 31 should be forwarded or discarded. If the packet is to be discarded, the metadata processor signals the input port to delete it from memory (col. 7, lines 35-57). If metadata processor decides the stored packet is to be forwarded, it forwards the metadata packet to the output port that is to receive the packet, which thereafter requests the input port to forward the packet stored in memory 31 (col. 7, lines 3-28). The input port responds to the request by reading the packet from its memory 31 and sending it to an inter-port packet switch 22 (col. 7, lines 28-35) which breaks the packet into segments and forwards each segment to the output port via a separate switch plane (col. 5, line 60 through col. 6, line 9). The output port then reassembles the segments into the packet (col. 6, line 4-9) and forwards the packet outward from the switch.

In step a of claim 1, the switch port generates a cell sequence corresponding to an incoming packet. As discussed above, Schwartz's input port stores an incoming packet in its entirety in memory and thereafter either discards the packet or forwards it to a packet segment generator. The packet segment generator then divides the packet into segments and forwards them to an output port via separate switch planes. If one broadly interprets "segments" as being the recited "cells," then Schwartz arguably teaches step 1 of claim 1 (and the "first means" of claim 11) since Schwartz literally teaches to receive a packet and then convert it into a sequence of segments/cells, even though between receiving the packet and generating the segment/cell sequence, Schwartz's port stores the packet in memory, reads it back out of memory, and forwards it to the inter-port packet switch.

In step b of claim 1, a determination is made with respect to at least one cell of the sequence generated at step a, as to whether to discard the cell or to store it in memory. The cell is then discarded or stored in memory based on that determination. Thus step b of claim 1 indicates that the packet is converted into a cell sequence before anything is stored in memory, and a cell of the sequence is either stored in memory or discarded. Schwartz teaches to store the entire packet in memory first and to then decide whether to discard the

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packet in its entirety or to read the packet out of memory, forward it to the packet segment generator which converts it into a sequence of segments. Thus Schwartz fails to teach step b because

      1. Schwartz teaches to store <u>entire packets</u> in memory rather than <u>cells</u> derived from the packet as recited in step b,

      2. Schwartz teaches to decide whether to discard on a <u>packet-by-packet</u> basis rather than on a <u>cell-by-cell</u> basis as recited in step b,

      3. Schwartz teaches to discard data only <u>after</u> it has been written in memory rather than before as recited in step b.

      Schwartz's input port makes inefficient use of memory since it stores packets that are to be discarded. The applicant's system is advantageous because it uses memory to store only cells that are to be forwarded. The Examiner correctly refrains from citing Epps as teaching step b of claim 1. Thus the combination of Schwartz and Epps fails to teach or suggest claim 1, step b or the "second means" of claim 11.

      Claim 1, step c recites "reading cells out of the memory and forwarding them from the network switch port". Schwartz does not teach reading cells out of memory; Schwartz teaches reading <u>packets</u> out of memory. The Examiner correctly refrains from citing Epps as teaching step c of claim 1. Thus the combination of Schwartz and Epps fails to teach or suggest claim 1, step c or the "third means" of claim 11.

      Claim 1, step d recites "generating an estimate of an average number of cells stored in memory". The Examiner correctly refrains from citing Schwartz as teaching step d of claim 1 since Schwartz teaches to discard packets read out of memory based on <u>output port capacity</u> (col. 11, lines 20-41), not based on an average number of cells stored in an <u>input port memory</u>. The Examiner incorrectly cites Epps as teaching step d of claim 1. Claim 1 step d recites to estimate an average number of <u>cells</u> stored in memory. Epps teaches a switch port (130, FIG. 2) that stores <u>incoming packets</u> in a memory 285, not cells. Thus neither Schwartz nor Epps teaches step d of claim 1 or the "fourth means" of claim 11.

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Claim 1 is therefore patentable over the combination of Schwartz and Epps, because neither reference teaches the recited steps b and d, and claim 11 is patentable over the combination of Schwartz and Epps, because neither reference teaches the recited second means, third means or fourth means.

Claims 2 and 12

Claims 2 and 12 depend on claim 1 or 12 and are patentable over the combination of Epps and Schwartz for reasons similar to those expressed above in connection with claims 1 and 11.

Claims 2 and 12 further recite "assigning each cell a discard weight" which is then used to determine whether the cell is to be discarded by comparing it to a random number. Schwartz teaches to divide a packet read out of memory into segments (which could be considered a form of "cells") which are then forwarded to an output port, but does not teach to assign a discard weight to each such segment. Epps teaches only to assign discard weights to packets, and does not teach to assign discard weights to individual cells of cell sequences derived from packets as recited in claims 2 and 12. The Examiner suggests that it would be obvious to apply Epps teaching to Schwartz whereby each of Schwartz's segments would be assigned a discard weight which would control whether the segment would be discarded. However in the context of Schwartz's teaching, this would be of no benefit with respect to preventing overload of input port memory since the segments are not created until after the packet from which they are derived have been stored in memory, and discarding segments of a packet being forwarded to an output port would serve no purpose.   Claims 2 and 12 are therefore further patentable over Epps and Schwartz because neither references teaches assigning each cell a discard weight and one of skill in the art would not be motivated to combine the references in the manner suggested by the Examiner.

Claim 10

Claim 10 depends on claim 1 and is patentable over the combination of Epps and Schwartz for reasons similar to those expressed above in connection with claim 1.

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Claim 10 further recites "the estimated average number of cells stored in the memory is estimated … whenever there is a change in a number of cells currently stored in the memory." Schwartz does not teach to estimate an average number of cells in memory. Epps teaches only to estimate an average number of <u>packets</u> in memory, and does not teach to estimate an average number of <u>cells</u> in memory. Claim 10 is therefore further patentable over the combination of Schwartz and Epps, because neither reference teaches to store cells in a memory or to estimate an average number of cells stored in a memory.

Claims 7 and 17

Claims 7 and 17 depend on claim 1 or 11 and are patentable over the combination of Epps and Schwartz for reasons similar to those expressed above in connection with claims 1 and 11.

Claims 7 and 17 further recite estimating an average number of cells stored in memory as a weighted sum of <u>cells</u> currently stored in memory and a last computed average number of cells stored in memory. The Examiner cites Epps, col. 31, lines 8-20 and col. 32, lines 4-67 as teaching this, however while these sections relate to average number of <u>packets</u> in memory for a given queue, not to average number of <u>cells</u> in the a memory. Claims 7 and 17 are therefore further patentable over the combination of Schwartz and Epps, because neither reference teaches to store cells in a memory or to estimate an average number of cells stored in a memory.

Claims Appendix

1. A method for a network switch port for receiving and storing data included in incoming packets that vary in size and then forwarding the data from the network switch port, the method comprising the steps of:

a. receiving each incoming packet and generating a cell sequence corresponding to the incoming packet, wherein each cell of the cell sequence contains a separate portion of the data included in the incoming packet, and wherein each cell of each generated cell sequence is of a uniform size;

b. making a determination with respect to at least one cell of each cell sequence generated at step a as to whether to discard the

cell or to store the cell in a memory, and then one of storing or discarding the cell in the memory in accordance with the determination;

    c. reading cells out of the memory and forwarding them from the network switch port; and

    d. repetitively generating an estimate of an average number of cells stored in the memory during a period immediately preceding generation of the estimate, wherein the determination made at step b is a function of the generated estimate.

    2. The method in accordance with claim 1 wherein step b comprises the substeps of:

    b1. assigning the cell a discard weight that is a function of the estimated average number of cells stored in the memory generated at step d;

    b2. generating a random number;

    b3. comparing the cell's assigned discard weight to the random number to produce result data indicting whether the discard weight exceeds a value of the random number,

    b4. making the determination as to whether to discard the cell or to store the cell in the memory as a function of the result data; and

    b5. one of storing or discarding the cell in the memory in accordance with the determination made at step b4.

    3. The method in accordance with claim 2 wherein the discard weight assigned to the cell at step b1 is a function of an amount by which the estimated average number of cells stored in the memory exceeds a threshold level.

    4. The method in accordance with claim 2 wherein step b1 comprises the substeps of:

    b11. allocating a separate discard weight for each of a plurality of separate number ranges,

    b12. determining which particular number range of the plurality of separate number ranges includes the estimated average number of cells stored in the memory, and

b13. assigning the allocated discard weight of the particular number range to the cell.

5. The method in accordance with claim 4 wherein the discard weight for each of said plurality of number ranges is allocated at step b11 as an increasing function of magnitude of number values spanned by the number range.

6. The method in accordance with claim 2 wherein step b comprises the step of:

b1. making the determination with respect to a first cell of the cell sequence as to whether to discard that first cell and all other cells of the cell sequence based on a comparison of the first cell's assigned discard weight and the random number, and on whether a current number of cells stored in the cell memory at the time the determination is made exceeds a predetermined threshold level; and

b2. one of discarding all cells of the cell sequence or storing all cells of the sequence in the memory in accordance with the determination made at step b1.

7. The method in accordance with claim 1 wherein the step d of repetitively generating an estimate of an average number of cells stored in the memory during a period immediately preceding generation of the estimate comprises the substeps of:

a1. multiplying a last computed average number of cells stored in the memory by a value of a parameter X between 0 and 1 to produce a first value,

a2. multiplying a number of cells currently stored in the memory by a quantity (1-X) to produce a second value, and

a3. generating a next estimate of the average number of cells stored in the memory, as a sum of the first and second value, and

a4. iteratively repeating steps a1 through a3.

8. The method in accordance with claim 1 wherein step b comprises the substeps of:

b1. allocating a separate discard weight for each of a plurality of separate number ranges;

b2. determining which particular number range of the plurality of separate number ranges includes the estimated average number of cells stored in the memory;

b3. assigning the allocated discard weight of the particular number range to a first cell of each sequence,

b4. generating a random number;

b5. comparing the cell's assigned discard weight to the random number to produce result data indicting whether the discard weight exceeds a value of the random number;

b6. making the determination with respect to a first cell of the cell sequence as to whether to discard that first cell and all other cells of the cell sequence based on a comparison of the first cell's assigned discard weight and the random number; and

b7. one of discarding all cells of the cell sequence or storing all cells of the sequence in the memory in accordance with the determination made at step b6.

9. The method in accordance with claim 8 wherein the step d of repetitively generating an estimate of an average number of cells stored in the memory during a period immediately preceding generation of the estimate comprises the substeps of:

a1. multiplying a last computed average number of cells stored in the memory by a value of a parameter X between 0 and 1 to produce a first value,

a2. multiplying a number of cells currently stored in the memory by a quantity (1-X) to produce a second value, and

a3. generating a next estimate of the average number of cells stored in the memory, as a sum of the first and second value, and

a4. iteratively repeating steps a1 through a3.

10. The method in accordance with claim 1 wherein the estimated of the average number of cells stored in the memory is estimated at step d whenever there is a change in a number of cells currently stored in the memory.

11. An apparatus for receiving, storing and then forwarding data in a plurality of incoming packets that vary in size, the apparatus comprising:

a memory;

first means for receiving each incoming packet and for generating a cell sequence corresponding to the incoming packet, wherein each cell of the cell sequence packet contains a separate portion of the data included in the incoming packet, and wherein each cell of each generated cell sequence is of a uniform size;

second means for making a determination with respect to at least one cell of each generated cell sequence to whether to discard the cell or to store the cell the memory;

third means for one of storing or discarding the cell in the memory in accordance with the determination made by the second means, and for reading cells out of the memory and forwarding them; and

fourth means for repetitively generating an estimate of an average number of cells stored in the memory during a period immediately preceding generation of the estimate,

wherein the determination made by the second means is a function of the generated estimate.

12. The apparatus in accordance with claim 11 wherein the second means comprises:

fifth means for assigning each cell a discard weight that is a function of the estimate generated by the fourth means;

sixth means generating a random number;

seventh means for comparing the cell's assigned discard weight to the random number to produce result data indicting whether the discard weight exceeds a value of the random number,

eighth means for making the determination as to whether to discard the cell or to store the cell in the memory in response to the result data.

13. The apparatus in accordance with claim 12 wherein the discard weight assigned to each cell is a variable function of the estimated average number.

14. The apparatus in accordance with claim 12 wherein the fifth means allocates a separate discard weight for each of a plurality of separate number ranges, determines which particular number range of the plurality of separate number ranges includes the estimated average number of cells stored in the memory, and assigns the allocated discard weight of the particular number range to the cell.

15. The apparatus in accordance with claim 14 wherein the fifth means allocates the discard weight for each of the plurality of number ranges as an increasing function of magnitude of number values spanned by the number range.

16. The apparatus in accordance with claim 12 wherein the eighth means makes making a determination with respect to a first cell of each cell sequence as to whether to discard that first cell and all other cells of the cell sequence based on a comparison of the first cell's assigned discard weight and the random number, and on whether a current number of cells stored in the cell memory at the time the determination is made exceeds a predetermined threshold level.

17. The apparatus in accordance with claim 11 wherein the fourth means comprises:
means for multiplying a previously generated estimate of an average number of cells stored in the memory by a value of a parameter X between 0 and 1 to produce a first value,
means for multiplying a number of cells currently stored in the memory by a quantity (1-X) to produce a second value, and
means for generating a next estimate of the average number of cells stored in the memory, as a sum of the first and second value.

18. The apparatus in accordance with claim 11
wherein the second means comprises:
fifth means for allocating a separate discard weight for each of a plurality of separate number ranges;
sixth means for determining which particular number range of the plurality of separate number ranges includes the estimated average number of cells stored in the memory;

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seventh means for assigning the allocated discard weight of the particular number range to a first cell of each sequence;

eighth means for generating a random number;

ninth means for comparing the cell's assigned discard weight to the random number to produce result data indicting whether the discard weight exceeds a value of the random number; and

tenth means for making the determination with respect to a first cell of the cell sequence as to whether to discard that first cell and all other cells of the cell sequence based on a comparison of the first cell's assigned discard weight and the random number, and

wherein the third means one of discards all cells of the cell sequence or stores all cells of the sequence in the memory in accordance with the determination made by the tenth means.

Evidence Appendix

Not applicable.

Related Proceedings Appendix

Not Applicable.

Respectfully submitted,

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